2013 National Roadway Safety Award Nomination
Submitted by: The Connecticut Department of Transportation
Project Name: Rotary Conversion to Roundabout, Route 80 at Route 81
Town of Killingworth, Connecticut (Project # 69-76)

Project Description

Summary:

Like many New England states, Connecticut used to have a number of old traffic circles or rotaries. As these fell out of favor in the middle of the 1900's, many of these circular intersections were converted to conventional intersections controlled with traffic signals. However, in Connecticut a few survived and are still in existence. In about the middle of the last decade, the Connecticut Department of Transportation (Department) began to implement modern roundabouts in recognition of their proven safety benefits. The Insurance Institute for Highway Safety (IIHS) study on converting signalized and all-way stop controlled intersections to modern roundabouts was one catalyst for a national movement to implement roundabouts, showing a 39% reduction in crashes, a 79% reduction in injuries, and a 90% reduction on fatalities. However, there was little information available regarding converting rotaries to modern roundabouts. Nonetheless, the Department decided to investigate whether upgrading rotaries to roundabouts would be beneficial and cost effective. A review of several old rotaries was made and three were chosen as candidate locations based on crash history, volumes, constructability, and the potential for improvement. The first location which made it through to construction was at the intersection of Routes 80 and 81 in the town of Killingworth.

Located in southern Connecticut, west of the Connecticut River, Killingworth is a predominately rural town. Route 80 crosses through the town in an east-west direction, while Route 81 is a north-south route. Both roads are two lane undivided arterials. Route 81 has a 2010 Average Daily Traffic (ADT) volume of 10,300 vehicles per day while the ADT on Route 80 is 4,400 vehicles. Development in the project vicinity includes a convenience store/gas station, an inn (with a driveway within the circle), a commuter parking lot, a propane delivery company with large delivery trucks, and a state police barracks. The previous traffic circle (see Photo 1) was relatively small, approximately 140 feet in diameter, which is within the typical range of sizes for a modern roundabout. The most obvious deficiency with the previous circle was the lack of deflection on the entrances. Rotaries in general, and this one specifically, were configured to give the right of way to the entering traffic and the traffic in the circle had to yield. To accommodate this, the entrances had little if any deflection which allowed

for high speeds. Roundabouts are configured to give the right of way to the circulating traffic, requiring the entering traffic to yield, which has proven to be a far superior arrangement. In Killingworth, many decades earlier the Department changed the yield control so that entering traffic had to yield, but no changes to the geometry were made so entering traffic still had little to no deflection. The skewed alignment of the roads added to this problem. In fact, the outline of the intersection was not actually circular and was closer to a rectangle with a circle in the middle. The movements from Route 80 westbound to Route 81 northbound and from Route 80 eastbound to Route 81 southbound were essentially straight paths. The through movements on both Route 81 legs had only a small bump. However, the right-turn movement from both Route 81 legs to Route 80 was almost a U-turn, requiring slow speeds and the through movements from both Route 80 legs had some deflection, requiring drivers to slow to reasonable speeds. The significant speed differential between the various movements was seen as one reason that some drivers were wary of the location and a possible cause for some of the crashes that were occurring here. Ideally, all movements in a roundabout should be made at as close to a uniform speed as possible. This location was used as an example (although not named) of a roundabout with poor deflection in NCHRP Report 572 (Roundabouts in the United States). In addition, the splitter islands on the approaches were painted islands and drivers were observed making an illegal left turn, travelling clockwise against traffic, in order to make the left turn from either Route 80 leg to Route 81, due to the skew angle of intersection.

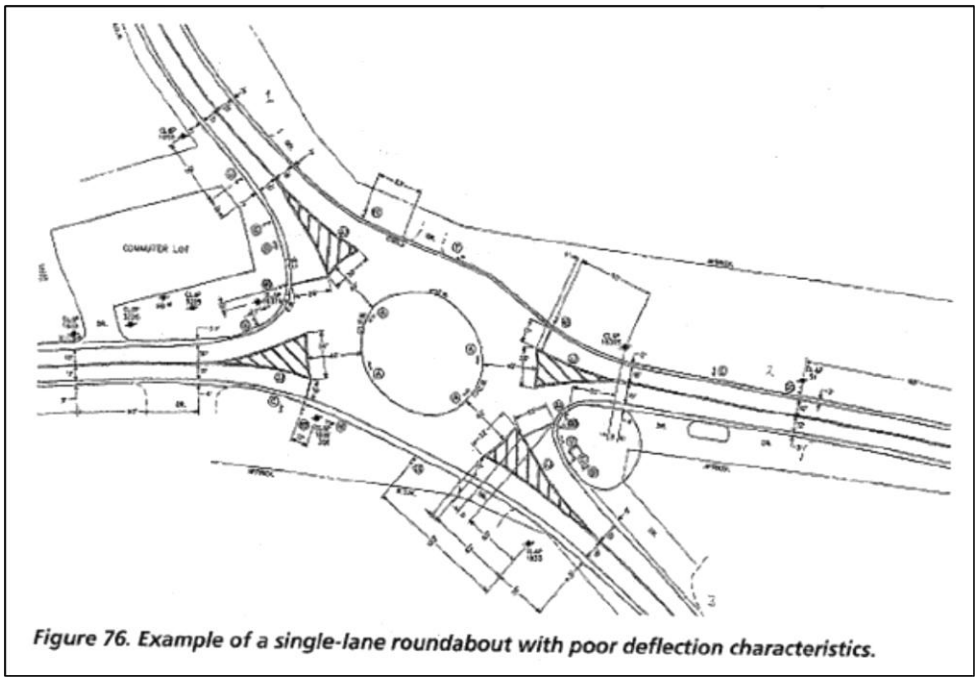

Figure 76. Example of a single-lane roundabout with poor deflection characteristics.

FIGURE 76 FROM NCHRP REPORT 572 (ROUNDABOUTS IN THE UNITED STATES)

The crash history at this location was not excessive in terms of number of crashes, but it was felt that high speeds seemed to be a contributing factor and there was a potential for a serious collision due to the speeds and angle of collisions, both of which were a result of the lack of deflection and skew angle of intersection. Between 2005 and 2007 (3 years) there were a total of 20 crashes, of which 6 were injury crashes, involving a total of 7 injuries (0 Type A, 1 Type B, 6 Type C). To address these crashes, the designers wanted to slow traffic on the approaches by creating some deflection and adding a truck apron around the central island (see Photo 2). The overall dimensions of the intersection were not altered but the east leg was realigned slightly to improve the angle of intersection. Private property and business considerations prevented more ambitious realignment work. In addition, raised splitter islands were installed to replace the painted splitter islands and raised truck "blisters" (raised truck aprons placed on the outside of the roundabout) were installed on two of the 4 quadrants. The truck blisters also allowed for movements by trucks that were not possible with the previous geometry. Some of the existing pavement was removed to create a more circular intersection shape which helped with the deflection and slowing of traffic. Comparing the latest available three year period (2009-2011) crash history to the 2005-2007 data, the total number of crashes was reduced from 20 to 10 (50% reduction), the number of injury crashes was reduced from 6 to 1 (83% reduction) and the number of injuries was reduced from 7 to 1 (86% reduction). The single injury in the three year period after construction was a Type C injury (which occurred at a commercial driveway 150 feet south of the roundabout).

Applicability to Award Criteria:

Effectiveness:

This purpose of this project was to reduce the number and severity of crashes as well as to make the intersection feel safer for drivers by reducing speeds and making them more uniform among the various movements. The crash data shows the project was successful in terms of crash and injury reduction. The IIHS study provided crash reduction data that could be expected when converting conventional intersections to roundabout, but there was little, if any, data on converting rotaries to roundabouts that would be applicable to this location. Consequently, no specific crash reduction goals were set for this project, but the designers informally hoped to see reductions in the general range of 20-30%. The actual reductions of 50% of total crashes and more importantly 86% reduction of injuries are well beyond expectations. This data is being used to help justify modifications at other rotaries in the state. The goal of reducing speeds was accomplished by adding deflection, raised splitter islands, a raised truck apron, raised truck blisters, realignment of one leg, and removal of some excess pavement. Speeds are now within the range of 15-20 MPH for all movements, eliminating the significant speed differentials that existed previously and creating a uniform range of speeds throughout the roundabout.

In addition to the crash and injury reductions, the intersection is generally considered safer by most users, based on informal comments received by the Department. This is primarily due to the reduction and uniformity of speeds. One group of users that has benefited from the improvements is bicyclists. Previously, the high speeds of cars travelling through the rotary were a deterrent to bicyclists. With the improvements in place, bicyclists have been observed riding through the roundabout and are able to keep pace with the motorized vehicles.

The project is also considered a success in terms of addressing public concerns. During the public involvement process, the owner of a local trucking company expressed concern about the ability of his "low boy" trucks to travel around the roundabout with the addition of the raised truck apron. To address his concern, the designers met him at his business, took measurements of his vehicles and made some minor revisions to the design to ensure he would be able to traverse the roundabout. These efforts were appreciated by the owner of the trucking company and no issues have been reported.

Innovation:

One concern expressed by certain members of the public regarded the appearance of the roundabout as compared to the previous rotary. The central island of the rotary was grassed and contained a large tree (which died and was removed prior to the construction of the project). The public wanted to retain a landscaped appearance and were concerned about the introduction of a large concrete truck apron. However, in order to accommodate the trucks using this location, especially the low boy trucks

noted previously, the truck apron had to be fairly wide and might have been seen as too much concrete. To mitigate these conflicting issues, the designers chose to implement a design feature never before used for this application – the inside half of the truck apron was constructed using concrete "waffle blocks" (see Photo 3). These waffle blocks were concrete pavers with square holes to allow grass to grow through them. The resulting effect was to provide a surface capable of withstanding the occasional use by a very large truck, while still appearing to most drivers to be an extension of the landscaped central island. To date, the blocks have held up well. The grass growing through the blocks was initially established, however in recent years it has not re-established as hoped. This is felt to be a result of poor soil installed under the project and over compaction (much of the landscaping installed in this project did not survive), which the Department hopes to rectify at some point in the future. Overall, the use of the waffle blocks is considered to be a success and they may be used in similar future applications.

Another innovative solution used at this location was implemented to address a concern from the Department's Maintenance forces. They were concerned about the addition of the raised splitter islands and the ability of snow plow drivers to be able to locate the islands when covered with snow. To address this, the designers included small sleeves in the poured concrete splitter islands. Each fall, before the start of the snow season, Maintenance installs small flexible delineators into these sleeves which plow drivers use to locate the edges of the splitter islands, and subsequently remove them in the spring. This was coordinated with the local Maintenance garage and is being incorporated into all future roundabout designs.

Efficient Use of Resources:

The skewed geometry of the intersection prior to this project presented a major challenge to the goals of reducing speeds. Consideration was given to including major realignment of two or more of the intersection legs to form more conventional right angles between each leg. However, the crash history did not support the substantial cost that would be involved with such a design, especially when taking into account the resulting acquisition of private property that would be required. The designers took a constrained approach to the design of this project, choosing to realign only one leg, where the existing right of way allowed for the work to be completed without the need for additional acquisition. They also kept the modified design within the confines of the existing circle, even removing some existing pavement, which helped contain costs. However, keeping the new intersection within the footprint of the old intersection created a challenge regarding the need to install a raised truck apron. In order to fit the truck apron within the existing footprint, the central island would have to be slightly reduced in size. To offset the aesthetic impact of a smaller central island, the inside half of the apron was constructed with the waffle blocks described previously. The total construction cost of the project, including inspection costs and utility relocations was approximately $1.1 million.

Photos

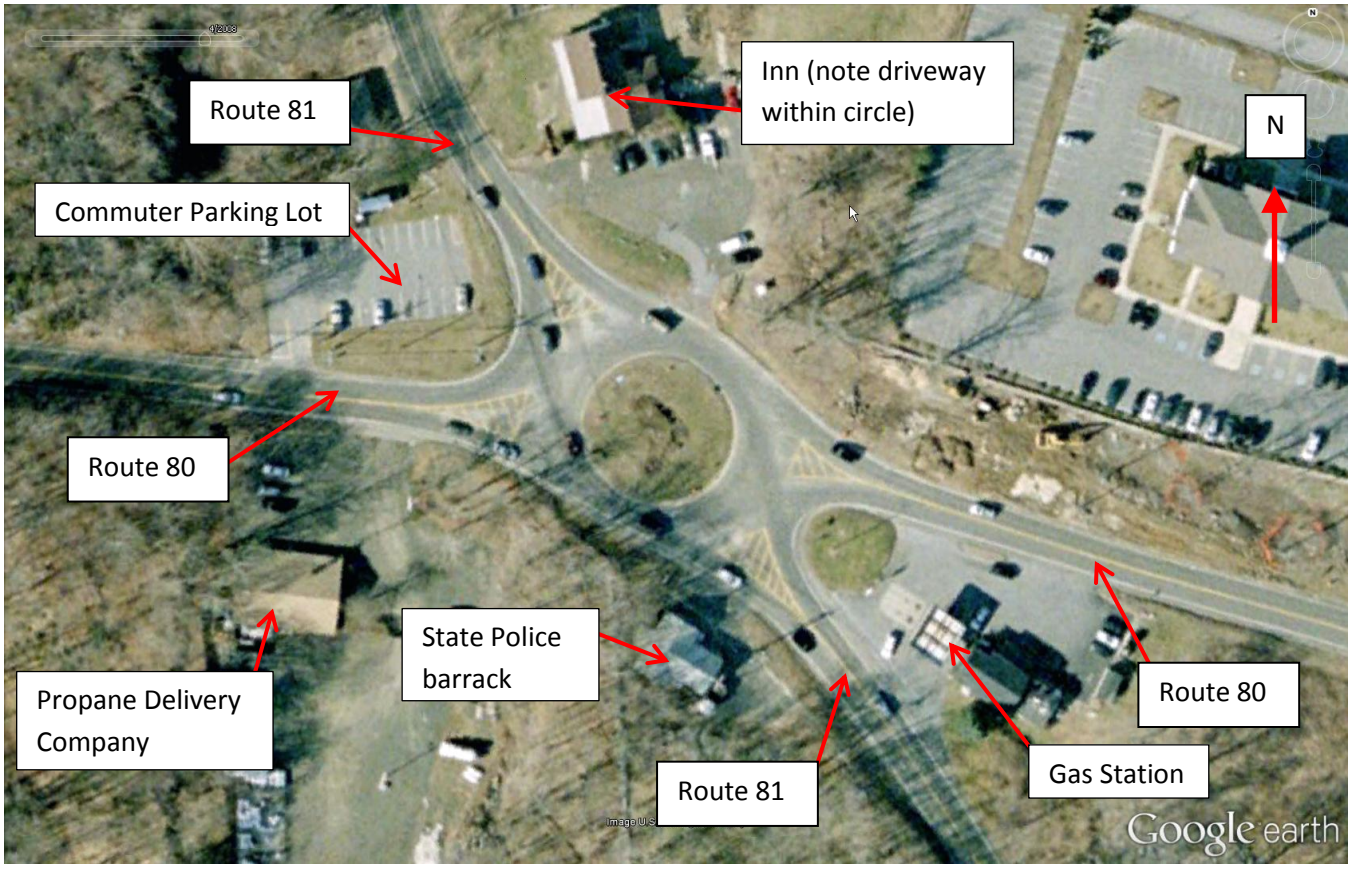

Photo 1 – Previous condition. Note painted splitter islands, lack of deflection.

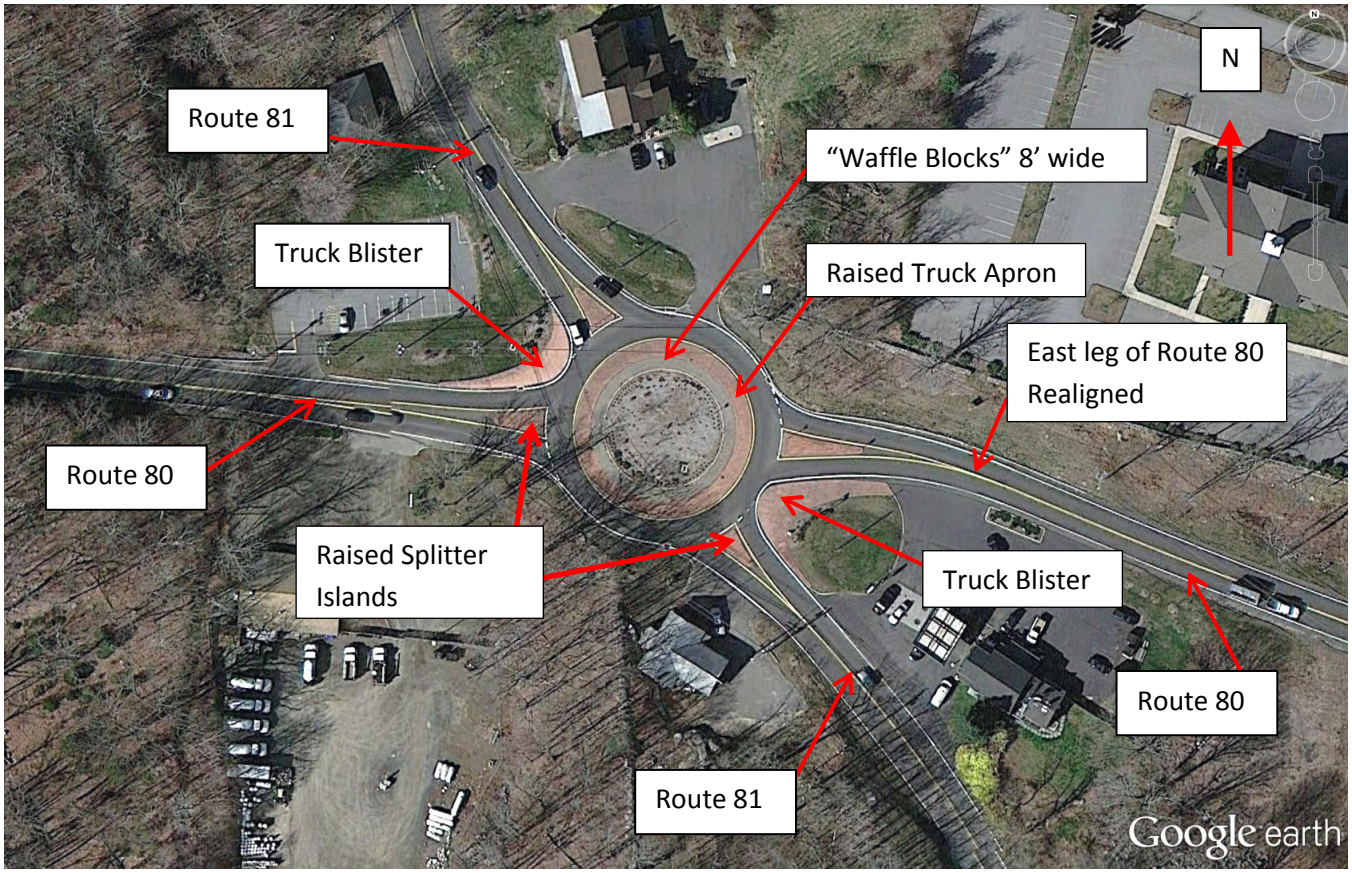

Photo 2 – Intersection converted to modern roundabout.

Photo 3 – View of completed roundabout looking north towards central island. Inset – close-up view of concete "waffle blocks" with grass growing through making landscaped central island appear larger.

Before and After Crash Review

Town of Killingworth, CT
Conversion of Rotary to Modern Roundabout
Route 80 at Route 81
Project 69-76

Mileage:
Route 80: 18.13 to 18.29 = 0.16 miles
Route 81: 5.93 to 5.97 = 0.04 miles

Before period: 1/1/2005 to 12/31/2007 = 36 months
After Period: 1/1/2009 to 12/31/2011 = 36 months

CRASHES BY SEVERITY:

			Change	
	Before	After	#	%
Fatal Crashes:	0	0	0	0.0%
A Injury	0	0	0	0.0%
B Injury	1	0	-1	-100.0%
C Injury	5	1	-4	-80.0%
Total Injury Crashes:	**6**	**1**	**-5**	**-83.3%**
Property Damage Only:	14	9	-5	-35.7%
Total Crashes:	**20**	**10**	**-10**	**-50.0%**

TOTAL INJURIES BY SEVERITY:

			Change	
	Before	After	#	%
Fatal:	0	0	0	0.0%
A Injury	0	0	0	0.0%
B Injury	1	0	-1	-100.0%
C Injury	6	1	-5	-83.3%
Total Injuries:	**7**	**1**	**-6**	**-85.7%**

CRASH ANALYSIS ASSUMPTIONS AND LIMITATIONS

1. The mileage limits chosen are the project limits of construction. Because of the realignment work on Route 80, the length of section reviewed is longer on that road than on Route 81.
2. Construction of the project occurred in 2008, from approximately April through November.
3. Traffic volumes within the project limits were reviewed. The ADT on Route 80 in 2007 was 4,400 on the west leg and 4,300 on the east leg. The 2010 ADT was 4,400 on both legs. On Route 81, the ADT on the north and south legs was 10,000 and 9,100 respectively in 2007 and 10,300 and 9,500 respectively in 2010. Since the changes in volumes are so minimal, they have been discounted in the crash analysis.